Understanding digital health: productive tensions at the intersection of sociology of health and science and technology studies

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Abstract

In this editorial introduction, we explore how digital health is being explored at the intersection of sociology of health and science and technology studies (STS). We suggest that socio-material approaches and practice theories provide a shared space within which productive tensions between sociology of health and STS can continue. These tensions emerge around the long-standing challenges of avoiding technological determinism while maintaining a clear focus on the materiality and agency of technologies and recognising enduring sets of relations that emerge in new digital health practices while avoiding social determinism. The papers in this Special Issue explore diverse fields of healthcare (e.g. reproductive health, primary care, diabetes management, mental health) within which heterogenous technologies (e.g. health apps, mobile platforms, smart textiles, time-lapse imaging) are becoming increasingly embedded. By synthesising the main arguments and contributions in each paper, we elaborate on four key dimensions within which digital technologies create ambivalence and (re)configure health practices. First, *promissory digital health* highlights contradictory virtues within discourses that configure digital health. Second, *(re)configuring knowledge* outlines ambivalences of navigating new information environments and handling quantified data. Third, *(re)configuring connectivity* explores the relationships that evolve through digital networks. Fourth, *(re)configuring control* explores how new forms of power are inscribed and handled within algorithmic decision-making in health. We argue that these dimensions offer fruitful perspectives along which digital health can be explored across a range of technologies and health practices. We conclude by highlighting applications, methods and dimensions of digital health that require further research.

Keywords: Digital health, digital sociology, sociotechnical practices, socio-materiality, care, e-health, telemedicine, science and technology studies (STS)

'Digital health' is both easy and hard to define, not least because of its close relationship to other broad terms such as 'e-health' or more specific terms that might be seen as sub-sets of digital health, such as 'telehealth', 'telemedicine' or 'mobile health', which imply more mobile forms of care. Several definitions have been put forward by sociologists seeking to make sense of digital health (Lupton, 2018a; Petersen, 2019). Lupton, for example, has described digital health as

> 'a wide range of technologies directed at delivering healthcare, providing information to lay people and helping them share their experiences of health and illness, training and educating healthcare professionals, helping people with chronic illnesses to engage in self-care and encouraging others to engage in activities to promote their health and well-being and avoid illness' (Lupton, 2018a, p. 1).

She and others have also identified the range of technologies and/or the various theoretical approaches that have contributed to our understanding of digital health in attempts to map the field (see, e.g., Lupton, 2016b; Lupton, 2018a, 2017; Petersen, 2019). These contributions serve as important reminders of the depth and breadth of the digital health field and its constitution in different disciplines and have provided clear insights into the ways in which digital devices are becoming increasingly embedded in healthcare organisations and care delivery. These include attention to the mutually constitutive relationship between digital technologies and healthcare practices. Despite this, there remains a tendency in many digital health studies to 'read off' from the functionalities or capacities of specific digital devices to assess their likely implications for healthcare or to attribute transformations in healthcare delivery to devices without any clear analysis of *how* digital technologies are implicated in the (re)configuration of healthcare practices. One of the main motivations for us in putting together this collection was to examine this question more directly.

At this point, we must locate ourselves more fully. As sociologists working at the boundary of sociology of health and science and technology studies (STS), our main interest is with exploring understandings of digital health at the intersection of these two fields. We do this by reflecting, briefly, on how technology has been understood in both sociology of health and STS and suggest that socio-material approaches and practice theories provide a shared space within which productive tensions between sociology of health and STS continue to be addressed. We then introduce the papers in this collection to illustrate these points.

Health sociology and STS: Overlaps and productive tensions

A central focus of much sociology of health has always been a critique of individualised, behaviour change models (derived from health psychology) where human agency is foregrounded, where individuals are the unit of analysis and where change comes as result of rational decision-making and

informed choice. Sociology of health has typically countered this understanding by drawing attention to the structural determinants of health, where social structures are foregrounded, where health outcomes are determined by structural factors (e.g. class, gender, ethnicity etc.) and where positive change comes as result of improving conditions in which people live and work. In both these approaches, technology is often understood, rather uncritically, as a *tool.* In behaviour change models, it is understood as a tool to achieve goals, either for individuals (e.g. health benefits through use on Internet to inform oneself) or for organisations (e.g. to deliver more effective and efficient healthcare by application of new technologies). In a structural determinants approach, technology is also often seen as a *tool* – here, used by dominant groups to rationalise work (de-skilling argument) or to further oppress marginalised groups (e.g. women in the case of reproductive technologies type arguments). Even in some post-structuralist/Foucauldian approaches, especially in critiques of neo-liberalism and 'responsibilisation', technology is often presented as a tool – in this case, for disciplining patients and citizens and leading to negative outcomes for health. Such formulations might be understood as enacting a soft technological determinism, which is surprising given the close link between Foucauldian approaches and practice theories which challenge all forms of determinism. The challenge of avoiding technological determinism while maintaining a clear focus on the materiality and agency of technologies has been best addressed through practice theory, especially in its post-humanist forms.

While humanist practice theories (Bourdieu, 1984; Giddens, 1984) might be seen as overlooking the agency of technologies, post-human practice theories, associated with the 'material turn' in social theory, understand materials as active agents and participants in practice (Reckwitz, 2002; Schatzki, 1996). Here, while the human subject is still understood as having agency, s/he is de-centered. Working in sociology, but at the intersection with STS, Shove et al.'s (2012) practice theory defines practices to include three key elements – meanings, *materials* and skills/competences, with materials being further defined as objects, tools and infrastructures. In this version of practice theory, people are understood as carriers of practice, with practices understood as performance. This approach has been particularly well developed in relation to public health (Harries & Rettie, 2018; Keane, Weier, Fraser, & Gartner, 2017; Supski, Lindsay, & Tanner, 2017; Williams, Weiner, Henwood, & Will, 2018).

There is a close overlap here with practice theories that have emerged within STS, from actor network theory (ANT) onwards (Latour, 2005). From an STS point of view, science (including medical science) and technologies have always been a specific focus of analysis and part of the *raison d'être* of this field has been to critique all forms of technological determinism and instrumentalism in social theory. Thus, social shaping theory (MacKenzie & Wajcman, 1999) drew attention to the social, political and economic forces that shape technology's funding, design and innovation processes. Social constructivism (Bijker, Hughes, Pinch, & Douglas, 1987) pointed to the mutually constitutive relationship between technology and the social, so that technologies have 'interpretive flexibility' as they develop (albeit achieving 'temporary closure' at specific points, understood as allowing the 'black boxing' of technologies). Following ANT, more recent accounts of the relationship between technology

and the social in STS derive from, and in different ways enact, a post-humanist understanding. Here, the unit of analysis is heterogeneous practices which carry and produce relations and both humans and technologies are effects or 'achievements' of these practices. In socio-materialist accounts of practice, both material and discursive relations are addressed – hence Haraway's (1991) term 'material-semiotics'. Again, there are different versions, but all emphasise 'relational networks' or 'assemblages' of human and non-human actors and materiality is understood in a relational, emergent sense, with an emphasis on performativity – on 'becoming rather than being' (Barad, 2007; Braidotti, 2006; Knorr-Cetina, 1997; Latour, 2005; Mol, 2002). For example, adopting a material-semiotic approach to the study of telecare, Pols demonstrates the value of analysing what people and devices 'do' as the achievement of practices rather than as points of departure (Pols, 2012). She shows that while different devices may support different forms of care or help them emerge, they do not lead inevitably to those places (Pols, 2012). In her study, webcams, introduced to encourage patient peer support, worked best when patients already knew each other, showing that, while webcams couldn't create intimacy, they could help maintain it.

While it is interesting to note how socio-materialism offers a point of overlap between sociology of health and STS and creates a space within which to examine the heterogeneous practices of digital health, it is equally important to note on-going tensions between sociology of health and STS. As Law (2008, p. 632) has pointed out in his discussion of sociology's relationship to STS, theories and approaches that rely on systems or network logics (as socio-material practice theories do) tend to 'undo social foundations as an explanatory resource'. This is because, 'since systems have their own relational logic, the latter is likely to reshape the social as much as the technical' and thus the social is 'just as much in need to explanation as the technical' (ibid.). This can be problematic for sociologists working on health and illness, especially those working in a more critical tradition, who seek to explain enduring social orders such as health inequalities. A second, linked, tension arises because STS systems/network approaches tend to focus on *how* things happen, not *why* they do, so that questions focus on: '*How* they arrange themselves. *How* the materials of the world (social, technical, documentary, natural, human, animal) get themselves done in particular locations for a moment in all their heterogeneity' and how these interactions between elements enact realities and knowledges (Law, 2008, p. 632, italics in the original), again raising concerns for those working with more foundational and more critical sociologies that develop and rely on more explanatory theories to address 'why?' questions. In summing up the value of the concept of practice for the sociology of health, Cohn (2014, p. 160) makes a similar point when he notes that, in addition to having the potential to resist both the psychological and the individualising features that have come to define the term health behaviour, the concept of practice 'also potentially resists the search for causal explanations, in the form of identifying determinants, and instead embraces the idea that practices are contingent on a whole variety of social and material factors'.

The papers in this collection all illustrate, to different degrees, this resistance to the search for overall causal explanations. However, there are important differences of emphases across the papers in

terms of how they discuss the relationship between the social and the technological and how far and how explicitly they engage with deterministic and/or relational thinking. Thus, while it is probably fair to say that all papers share the assumption that digital health comprises sociotechnical practices and not simply technologies that impact upon health, they differ in the extent to which they engage with the materiality *in a relational sense*. Some papers give more emphasis to human than to non-human agency and give little insight into the specificities of the material devices and systems that help constitute the practices as they emerge. Others engage more directly with socio-materialism to show how the practices observed come into being and are sustained.

As a collection, the papers illustrate well the point that no, one, definition or theory of digital health will be sufficient to capture the diversity of sociotechnical practices involved. The collection is offered as a set of individual cases of digital health and a contribution to what we see as an on-going and productive debate between sociology of health and STS that addresses long-standing challenges of avoiding technological determinism while maintaining a clear focus on the materiality and agency of technologies and recognising enduring sets of relations that emerge in new digital health practices while avoiding social determinism.

In the next section, we introduce the papers in this collection. They cover diverse fields of healthcare (reproductive health, primary care, mental health, diabetes care) and diverse technologies (health apps, mobile platforms, smart textiles, time-lapse imaging) and are therefore able to demonstrate clearly the heterogeneity of digital health practices. However, as we suggest below, they can nevertheless be grouped to highlight key aspects of healthcare being (re)configured in response to the contradictions arising within new practices of digital health.

Key dimensions for approaching ambivalence of digital health

The papers in this collection explore the ambivalence at play when digital technologies become embedded within health practices. The notion of ambivalence has been developed to elaborate contradictory values that are experienced while engaging with quantified data, new forms of connectivity and algorithmic decision-making (Marent, Henwood, Darking, & EmERGE Consortium, 2018). By synthesising the main arguments and contributions in each paper of this collection we elaborate on four key dimensions within which digital technologies create ambivalence and (re)configure health practices.

First, *promissory digital health* outlines the configuration of discourses that enact contradictory virtues and imaginaries by which digital technologies and practices gain momentum within the provision of health. Second, *(re)configuring knowledge* highlights how ambivalence is experienced when digital information and data is generated, negotiated and shared within practices of care. Third, *(re)configuring*

connectivity elaborates new digital networks and their often contradictory implications for relationships and collaboration between different actors in healthcare. Fourth, *(re)configuring control* investigates algorithms and may produce new forms of authority within decision-making, diagnosis and treatment. In the following, we illustrate how these dimensions are helpful in exploring the ambivalence of digital health across the range of technological devices and fields of practices that are investigated in the papers of this collection.

I. Promissory digital health

The first important dimension of digital health we highlight concerns the question of how digital health is talked into being through promissory discourses and practices. Law and Singleton (2014, p. 381) have shown that policies can be seen as sets of heterogenous practices (done across various locations) that have potential to 'enact (phenomena) into being'. The first two papers in this collection show how digital health is discursively configured within policy documents including those of professional associations, governments and funding bodies.

Analysing policy documents through the lens of sociology of expectations (Brown & Michael, 2003), Martyn Pickersgill (in this collection) reconstructs the dynamics and momentum by which biomedical virtues generate legitimating tropes for new ventures in technology development. Pickersgill develops the notion of 'performative nominalism' in order to draw attention to the strategies of field-building by which professional associations, governments and funding bodies use their own neologisms to talk new therapeutic interventions into being. While Pickersgill's engagement with promissory digital health focuses on the specific case of digital psychiatry, his argument that 'purportedly novel fields have been constituted in part through practices of "performative nominalism" (whereby articulations of a neologism in relation to established and recent developments participate in producing the referent of the new term)' (Pickersgill, in this collection) could apply to digital health as a whole. Therefore, it is important to recognise how digital health becomes part of 'professional projects' (Abbott, 1988) and works as a means to gain status and expand territories. This is highlighted by other papers in this collection, for example, by demonstrating how online information is symbolically transformed in doctor-patient consultation to underscore professional competence (Stevenson et al.) or by reconstructing how global actors (such as the World Health Organisation) have built specific types of professional expertise into an algorithm that influences diagnosis of mental disorders on a global scale (Mills and Hilberg).

Another paper concerned explicitly with promissory discourse is by Emma Rich and colleagues (in this collection) who focus on digital health policy and undertake a critical discourse analysis of how inequality is performed within significant UK policy documents to reconstruct the *imaginary* that

underpins digital health. Building on critical sociological approaches to public health and health promotion (Baum & Fisher, 2014; Petersen & Lupton, 1996), they draw attention to the narrow framings of inequalities in digital health policy. They argue that while digital inclusion and inclusion in healthcare remain priorities for government, equality is being reassembled in ways that reflect broader discourses of neo-liberalism, empowerment and the turn to the market for technological solutions which may have the effect of exacerbating inequalities. Thus digital health policy reflects and reinforces such wider health policy in trying to tackle health inequalities via downstream solutions (reflected in the notion of 'lifestyle drift' (Willams & Fullagar, 2019). Rich et al.'s examination of the promissory discourse of digital health policy leads them to argue that the discourse enacts specific conditions of actions and types of selfhood, with citizens being positioned as objects of policy interventions in ways that assume particular agential capacities while, at the same time, obscuring the many social, political, cultural and economic inequalities that impede engagement with digital health.

While only these two papers deal explicitly with promissory digital health, we suggest that promissory discourse is more or less explicit within and across all further dimensions of digital health we discuss below and, as we introduce the rest of the papers, we point to the workings of such promises in both their positive and negative forms.

II. (Re)configuring knowledge

Under the topic '(Re)configuring knowledge', the contributions to this collection address the question of how health information and data is generated, interpreted and shared by digital means in ways that might (re)configure knowledges about medicine, the body and health. Since the early days of the Internet, the sociology of health has contributed useful insights in how this new digital landscape might be contributing to the reconfiguration of knowledge and provide a challenge to traditional doctor-patient relationships (Hardey, 1999; Henwood, Wyatt, Hart, & Smith, 2003). Nettleton's (2004) paper on 'e-scaped medicine' provided a particularly useful provocation for further studies to address the ways in which medical knowledge is being transformed into 'informational knowledge' (Lash, 2002) and thereby seen as potentially more accessible by, and shared between, patients and citizens. Many of these studies examined where and how such processes lead to challenges to medical authority and in what circumstances such challenges might result in the recalibration of doctor-patient asymmetries (Kivits, 2004, 2009; Mager, 2009; Ziebland & Wyke, 2012). Even these early studies showed clearly how becoming *informed* about one's health is not a simple matter of having access to information but requires complex processes of navigating, evaluating and negotiating different sources and types of knowledges, especially when their roots are obscured through these very processes of 'informatisation' (Henwood, Harris, Burdett, & Marshall, 2008) and how challenges to medical authority can lead to re-entrenched,

as well as reconfigured, relationships. The continuing growth and diversification of the Internet, especially the development of social media, the increasing use of mobile devices and the extension of consumer-facing developments such as 'direct-to-consumer' marketing, are all associated with a new set of tensions in digital health. The papers in this section seek to explore how the widespread availability of different types and forms of health information, discussion and debate across a range of platforms and enacted across a range of practices, complicates questions of credibility and trust, reconfigures notions of expertise and of citizen reflexivity and, in the context of quantified data, in particular, contributes the emergence of new and diverse patient and citizen subjectivities.

The paper by Alan Petersen and colleagues (in this collection) provides a particularly good example of the complexities and challenges of e-scaped medicine. They explore the criteria employed by Australian patients and carers to establish the credibility of information on controversial and unproven stem cell treatments, increasingly marketed directly to potential consumers. Seeking to find trustworthy information upon which to base their decisions about whether or not to travel abroad for such treatments, Petersen et al.'s patients attempt to enact the promissory 'informed patient' but are faced with the challenges of e-scaped medicine and competing claims about stem cell treatments from clinics, patient groups and other sources. The authors develop the concept of 'cartographies of trust' to describe the complex, often tortuous and emotionally fraught, paths by which individuals navigate various online and offline resources in order to decide for or against travelling abroad to receive treatments that are not provided in Australia. The authors show how, in the case of stem cells, where the scientific justification for many treatments offered was nascent, or in some cases non-existent, matters of opinion and belief are liable to be interpreted as matters of fact.

In contrast, Stevenson and her colleagues (in this collection) examine how General Practitioners (GPs) handle online resources in consultations to validate and explain knowledge to patients and offer them self-help outside the clinic. Using conversational analysis of videoed consultations, Stevenson et al. demonstrate the 'interactional delicacy' with which such resources are introduced and they discuss and develop Nettleton's (2004) idea of e-scaped medicine explicitly to argue that, in this case, Internet resources are 'recaptured' by GPs with information 'transformed and translated' (following Berg, 1992) into a medical offering that works to maintain the asymmetry between patients and practitioners necessary for successful functioning of medical practice.

In the work of Numerato and colleagues (in this collection), concerning how the vaccination debate unfolds on social media, promissory digital health is visible again – here, in the notion that the range of health resources available online can support the emergence of reflexive patients and citizens. The authors argue that the current information environment, dominated by digital communication platforms such as social network sites, requires further developments of our sociological imaginations of the 'reflexive' patient or citizen. Analysing vaccination debates on Facebook, the authors show how proponents and opponents of vaccination actively manage contradictory information about vaccination

(content-related reflexivity) in specific economic, political and informational environments (form-related reflexivity). They develop the notion of 'multi-layered reflexivity' to acknowledge social media sites as vehicles as well as objects of reflexivity and to problematise the epistemological capacities of agents to engage and validate public debates on health matters in the post-truth era,-joining a broader debate about how 'informational knowledge' changes ways of thinking and reasoning about health and medicine (Lash, 2002; Nettleton, 2004).

Relatively new literature on self-tracking has highlighted the ways in which digital technologies produce numerical data to provide novel opportunities to track health and monitor bodily conditions, which may produce new 'quantified selves' (Lupton, 2016a; Ruckenstein & Schüll, 2017; Schüll, 2016; Sharon, 2017). Pols and colleagues (in this collection) make the case for an 'empirical ethics' approach to this debate as an alternative to 'certain strands of critical sociology of technology', particularly that which focuses on the disciplining character of self-tracking devices, often linked to the responsibilisation thesis. The authors argue that this construction imagines a 'too uniform neo-liberal subject' that relies on a determinist understanding of technology as well as too broad a concept of reflexive modernisation. Through a re-interpretation of key texts on self-tracking (Schüll, 2016; Sharon, 2017; Sharon & Zandbergen, 2017), and new empirical data on everyday self-trackers, they seek to explore how people 'make sense with numbers' and how numbers 'make sense of people' in ways that show the interplay between freedom and power, determining and being determined, acting and being acted upon. They argue that it is precisely within these tensions that exist in different sets of relations that different 'selves' emerge. For example, only some subjects of self-quantification were found to present the 'objectivist-changer style' that is envisaged by health technology developers and problematised by health sociologists. The authors also identify 'aesthetic-semiotic subjects' that use quantified data, alongside sensing and feeling, to better know themselves and/or criticise existing norms and medical expertise. Therefore, the authors argue for more research that uncovers the various types of 'ethico-psychological subjects' of self-quantification to counter the assumed correlation between the use of health apps and behaviour change, so often emphasised within the promissory discourse of digital health.

III. (Re)configuring connectivity

Under the topic '(Re)configuring connectivity', we have grouped contributions that address the question of how new modes of connectivity affect relationships and collaboration between different actors in healthcare. The papers assembled under this topic are interested in how intimacy and mobility are produced and experienced within new forms of digital connection and how these can support remote forms of clinical follow-up, peer-support or bring forth a new kind of subtle medicalisation. Here, practice theories offer ways to move beyond dichotomous notions of 'cold technologies' and 'warm

care' to explore the specific circumstances within which telemonitoring and telecare practices can be central to achieving good care (Pols, 2012).

Enrico Piras and Francesco Miele follow an explicitly practice theoretical approach (Gherardi, 2010) to investigate computer-mediated communication through a remote monitoring platform connecting diabetes patients and healthcare professionals. The platform has an in-built, messaging system that works as a secure email service between patients and the ward, supporting asynchronous communication between healthcare professionals and patients between clinical visits. The authors argue that their case shows that digital care infrastructures can generate new forms of *digital intimacy* through the continuity of care (in-between clinic visits) and by complementing abstract medical knowledge ('knowing the patient') with exchange of personal messages that allowed clinicians to imagine themselves 'knowing about the patient' (Fairhurst & May, 2001). Thus, the affordances of platforms do not necessarily lead to more structured and impersonal interactions but can generate deliberative exchanges that complement medical data with patients' lifeworld experiences, contributing to feelings of being on 'the same page' and leading to more collaborative partnerships. Such in-depth empirical analyses challenge both optimistic and pessimistic readings of promissory discourses of digital health and bring forth understandings of how digital technologies can complement, or even enhance, traditional forms of care within specific embedding environments.

Ian Tucker and Anna Lavis (in this collection) explore digital connectivity within an online peer-support community where users may experience acute mental distress. Making the point that, in digital research, one cannot separate the digital device (e.g. an online platform) from the social phenomenon being studied there, they examine the experiences of mental health crisis as shaped by the online platform. Specifically, they examine how crises are 'constituted or disrupted in and through the complexities of fluctuating digital temporalities' (Tucker and Lavis, in this collection). The authors outline how online connections are often understood as transforming the spatial and temporal arrangements of healthcare by allowing support to be 'always on' and 'always there'. Online support can create a digital immediacy that shapes what comes to be seen as a mental health crises, and is set against the punctuated temporality of formal health services (in terms of access) even for people undergoing acute mental distress. However, their study showes that, once part of an online support group, new temporalities are established via new obligations to reciprocate support in a timely manner, via the re-living of difficult pasts and through decisions not to post for fear of triggering others. Their study suggests further areas for health sociology and STS to explore the temporalities of technologically-mediated interactions of mental health within both synchronous and asynchronous platforms.

Another form of connectivity – combining patients, monitoring machines and health professionals – is analysed by Kelly Joyce (in this collection). The focus in this paper is smart textile medical devices – clothing that uses sensors and fabrics to monitor bodily processes and communicates with data systems in formal hospital or clinical settings through wireless transmission. The cases analysed are the 'bellyband' that replaces the tocodynamotor and foetal heart rate monitor during labour and birth in

hospitals, and 'babyband' that replaces the cardiopulmonary monitor in neonatal intensive care units. The study examined these devices 'in the making', at the research and development stage. The paper analyses potential users' views of such smart textiles and explores contemporary contours of medicalisation (Conrad, 2007) and surveillance medicine (Armstrong, 1995). The study suggests that the soft fabrics of the bellyband contributed to feelings of being 'comfortable' with the device and the lack of wires was seen as having the potential to reduce labouring women's experiences of being 'tethered'. These feeling of comfort and potential for greater mobility contributed to its acceptability to intended users. Similarly, with the babyband, intended users were positive as the baby seemed to be wrapped in (babyband) pajamas, not hooked up to wires and machines. In particular, touch (important for parent-baby bonding) was seen as easier with babyband. Joyce argues that her case study suggests that smart textiles blur the boundary between hospital/medicine and home/daily life and, despite the fact that patients and devices are fully integrated into data systems, in these particular cases of blurring, medicalisation becomes 'cozy' and surveillance takes on a comfortable form. There were even suggestions that smart textiles could, perhaps paradoxically, support more 'natural' birth. Joyce argues that it is the invisibility and intimacy of the smart textiles that is crucial for this achievement. It is interesting to note that intended users were much less positive about the idea of expanding this monitoring into the home, especially in cases of routine pregnancy and infancy, a development that could easily follow the introduction of over-the-counter systems. Thus, their support was limited to cases where such monitoring was prescribed by clinicians in cases where there was a particular cause for concern and monitoring would otherwise take place in the hospital. While this was not a study of the technologies-in-use, users' anticipations about use suggests there is room for further research concerning the circumstances within which smart textiles produce cozy or less cozy forms of medicalisation.

IV. (Re)configuring control

Under the topic '(Re)configuring control', we have grouped papers that examine how digital algorithms might constitute new forms of authority that penetrate and transform practices of diagnosis and treatment. In different ways, these papers draw attention both to the ways in which authority is inscribed into systems at the design and development stage, and the ways in which algorithmic authority is disrupted, negotiated and reconfigured in different practices of use. The three papers in this section can be understood as engaging with promissory digital health as they investigate algorithmic healthcare in the context of conflicting virtues and values surrounding datafication and algorithmic reasoning. Both optimistic and pessimistic accounts circulate (albeit implicitly) within the practices examined, with the former emphasising algorithms' ability to provide more rational forms of diagnosis and prognosis, and the latter emphasising the ways in which algorithms embed new forms of control that threaten to displace human judgement, decision-making and even care.

China Mills and Eva Hilberg (in this collection) analyse the 'social life' of the WHO's mhGAP-IG algorithm (Mental Health Gap Action Programme Intervention Guide) that was created for non-specialists to diagnose mental health disorders globally. Conducting an ethnographic study, the authors observed how numbers and statistics were presented at WHO mhGAP forums and formed narrative tropes that emphasised treatment gaps and priority conditions around mental health. Following epistemic strategies associated with evidence-based medicine, the algorithm is reconstructed as an 'inscription device' (Latour & Woolgar, 1979) that reifies mental health in a particular way and thus also constitutes the condition it aims to diagnose. Through their post-colonial analysis of the algorithm's production, the authors reconstruct the power relationships built into this diagnostic tool and illustrate how this tool (already used in 80 countries) powerfully amplifies a narrow view of mental health that, when used on a global scale, risks displacing other forms of knowledge about mental distress. However, as Mills and Hilberg acknowledge, further research could investigate the performance and 'doing' of the mhGAP-IG beyond the development context and thereby contribute to the wider debate about how technologies are being 'tamed' and 'tinkered' with within situated practices, whereby algorithmic authority may become redefined or reduced (Hout, Pols, & Willems, 2015; Mol, Moser, & Pols, 2015).

This issue is the focus of Nete Schwennesen's paper (in this collection) which investigates the 'liveliness' (Lupton, 2018b) of an algorithm-based 'virtual trainer' that replaces the physical therapist and allows patients to undertake physical rehabilitation after hip replacement in their homes. Re-stating promissory discourse, she notes both optimistic and pessimistic accounts that see algorithms as either 'revolutionising healthcare' for the better through more rational forms of diagnosis and prognosis or as 'new forms of control' that will 'invade our lives' and displace humans. In both scenarios, algorithms are understood as if they are capable of acting alone. Her analysis challenges these perspectives by exploring the 'socio-material entanglements' by which the algorithmic system is made and enabled to work in practice. Through an ethnographic study across different sites, Schwennesen underscores the *liveliness of algorithms* and draws on Jasanoff and Kim (2015) to demonstrate how design 'imaginaries' differ from practices of use. While the system was designed to take on professional tasks in clinical practice (predictive diagnosis and treatment regimes in particular), Schwennesen charts the ways in which this 'algorithmic authority' is, in fact, negotiated and sometimes broken down in use, arguing that agency and authority do not adhere to the algorithm itself but are produced through associations made between social and material agencies including algorithmic imaginaries, policies, sensors, smartphones, IT workers, private companies, municipalities, physiotherapists and patients. In this way, Schwennesen builds successfully on the work of Pink et al (2018) to draw attention to the 'fragility' and 'incompleteness' of data and algorithms – how the algorithmic system needs to be adjusted and creatively 'repaired' to build and maintain meaningful connections that enable a productive (mutually constitutive) relationship between system and bodies undergoing rehabilitation. An important insight from Schwennesen's work concerns how we think about accountability in digital health. Her study demonstrates the need for a new mode of accountability focusing on how algorithmic systems come to

work in medical practice. This differs both from a 'transparency' approach (disclosure of factors that influence algorithmic decision-making) and an approach based on identifying 'bias' (embedded norms and values that may have discriminatory effects) and calls for an approach to accountability that takes into account the actual and concrete encounters between algorithms, health professionals and patients and the various forms of repair work that are needed to make algorithms work in practice.

Finally, Lucy van de Wiel's (in this collection) focuses on algorithms in the context of datafication of reproduction and how time-lapse embryo imaging enables a new 'algorithmic way of seeing' – 'in silico vision'. Time-lapse embryo imaging is designed to displace the embryologist's manual appraisal of embryos by filming them in the incubator, quantifying the visual information and predicting their viability through algorithmic analysis. Van de Wiel's paper focuses on new forms of knowledge production emerging within this data-driven time-lapse method of embryo selection and sets them in the techo-economic dynamics of an emerging global data infrastructure. She argues that this new method of embryo selection may not just result in more in-vitro fertilisation (IVF) success but also affects the conceptualisation and commercialisation of the assisted reproduction process and the coming into being of prenatal life. Although there is not much evidence to support the introduction of this new technology, van de Wiel points out that the market is growing rapidly and people using IVF increasingly have to decide whether to pay for this additional aspect of the IVF process. Unlike Schwennesen, van de Wiel does not examine clinicians and/or patient's engagement with the new technology. Rather, like Mills and Hilberg, she presents a rich and detailed account of the development of the new technology in its global context, tracing the 'genealogy' (following Vertommen, 2017) of data-driven embryo selection in the contemporary global fertility sector. As with Mills and Hilberg's paper, then, in addition to offering rich insight into ways in which new forms of algorithmic agency and authority are constituted, van de Wiel's work opens up further interesting avenues for research concerning how such agency and authority may be redistributed in different use practices.

Conclusion

The papers in this collection show how sociology of health and STS can work together, particularly in the space offered by socio-materialism, to develop more nuanced accounts of how digital health emerges in practice. By synthesising the main arguments and contributions in each paper of this collection, we have suggested that they point to four key dimensions within which digital technologies create ambivalence and (re)configure health practices in relation to promises, knowledge, connectivity and control. As suggested earlier, there are important differences in emphasis across papers – particularly in terms of levels of engagement with socio-materialism and on questions of politics and power. Thus, while all papers acknowledge both continuities and changes associated with the uptake of digital

technologies, some are more likely to emphasise the disturbances and disruptions to long-established traditions and vested interests in healthcare that arise when new technologies are introduced, drawing attention to power and hierarchy in care work (e.g. Pickergill; Stevenson et al.; Joyce) whereas others focus on continuity, understanding practices of care as always changing and therefore focus their attention on the kinds of adjustments made to achieve good fit between new digital technologies and relations of care (e.g. Schwennesen; Piras and Miele). Furthermore, while some papers make little mention of the wider political-economic landscape within which digital health is developing, others show how such developments are located clearly within the global systems of capital and governance (Mills and Hilberg; van de Wiel; Pickersgill) providing a useful prompt for more research into strategies of 'field-building' in digital health, exploring how professional bodies, governments and funders can all play a part in its consolidation. Rather than seeing these differences in emphases as options to choose between, we prefer to see them as examples of the productive tension between sociology of health and STS that encourages on-going debate and resists the closure of controversy that would result from the imposition of a universal perspective on digital health.

As with all collections, there are necessarily absences. The papers in this collection do not focus specifically on artificial intelligence, big data or robotics, although these areas are implicit in papers on algorithms (van de Wiel; Mills and Hilberg) and self-tracking (Pols). These are emerging technologies that will almost certainly dominate research on digital health produced over the next few years. Furthermore, we have not pulled out the spatiotemporal dimension of digital health although this is clearly important. While the papers in this collection arguably touched on spatiality by focusing on situated practices, cartographies of trust, new mobilities and the recapturing of e-scaped medical knowledge, the temporal has not been explicitly explored (Tucker and Lavis, notwithstanding) and a discussion of its relationship to the spatial is also lacking. However, it is clear that digital technologies are implicated in the enactment of new spatiotemporalities in healthcare, such as instant constructions of patient histories and projections about people's health. Future research may explore how lay people and professionals work with these new spatiotemporalities, as Lomborg et al (Lomborg, Thylstrup, & Schwartz) have done in relation to self-tracking and Marent et al. (2018) have done in relation to HIV care. Other emerging areas of digital health that have clear implications for spatiotemporalities include projections of pandemics (Opitz, 2017), embryonic evolution (van de Wiel, this collection) or genetic predictions for future health (Prainsack, 2017; Saukko, 2018).

Digital methods are also largely implicit in our collection, although current digital health technologies challenge researchers to re-think data sources and methods (Hine, 2015; Marres, 2017; Pink et al., 2016; Roberts, Snee, Hine, Morey, & Watson, 2016). A key aspect of the digital today is the ongoing capture of vast amounts of data about social life. Whether searching the web, engaging in an online discussion board or carrying the smartphone on us while cycling or running, the digital captures our transactions and movements continuously and in real-time. This creates a new source of, so-called, 'natural data' that has not been produced for scientific purposes but, nevertheless, is often used for

research or commercial exploitation. Only a few papers in this collection are based upon data sources produced within digitised environments – Facebook posts in a debate about vaccination (Numerato et al.), online messaging/posts in a mental health peer support network (Tucker and Lavis) and messages exchanged between health professionals and patients through a mobile health platform for diabetes care (Piras and Miele). These papers raise important questions about how established research methods such as observations or qualitative analysis need to be further developed. It will be important for further research to reflect explicitly on the challenges, opportunities and implications of applying digital methods within health research.

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